

# Fish Passage Construction

Update to Fish Passage and Stream Restoration Training  
2021 Fish Passage Construction Season

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HQ Hydraulics  
February 9, 2022  
River Restoration Northwest

This will  
be record

*To **inform** Fish Passage practitioners on the **challenges** associated with fish passage construction and implementing the **designs and specification** to **meet the project intent** and provide a water crossing that is **sustainable to fish passage** for the life of the crossing.*

*Water is the driving force of all nature.*

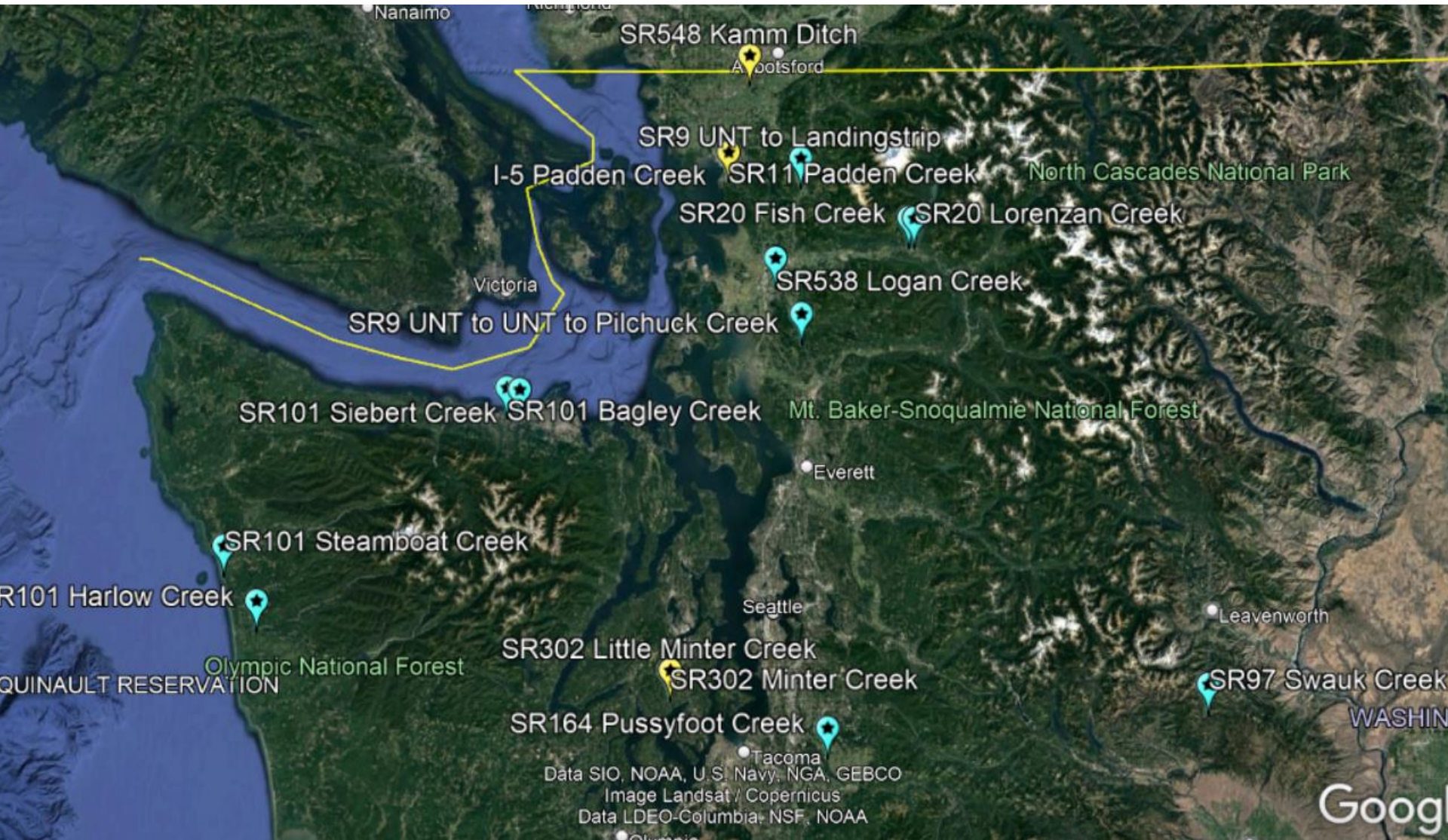
*Leonardo da Vinci*

# Learning Objectives



- Understanding high risk items and how to avoid them
- Seeking opportunities for improvements
- Interpreting and understand the designs & specifications pertaining to;
  - Streambed alignment/geometry
  - Streambed materials,
  - Channel complexities,
  - Large woody material,
  - Design plans & details

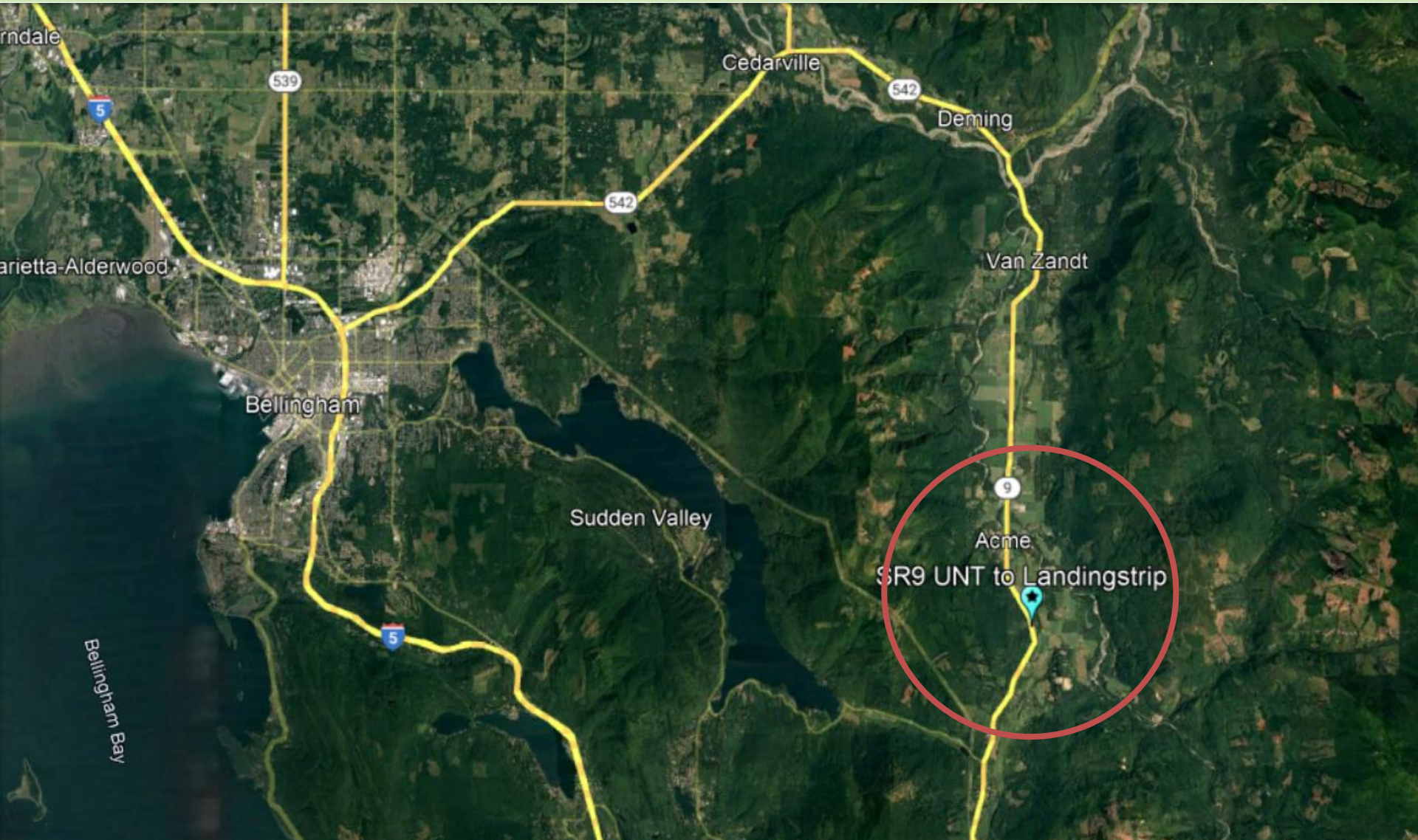
# Project Examples





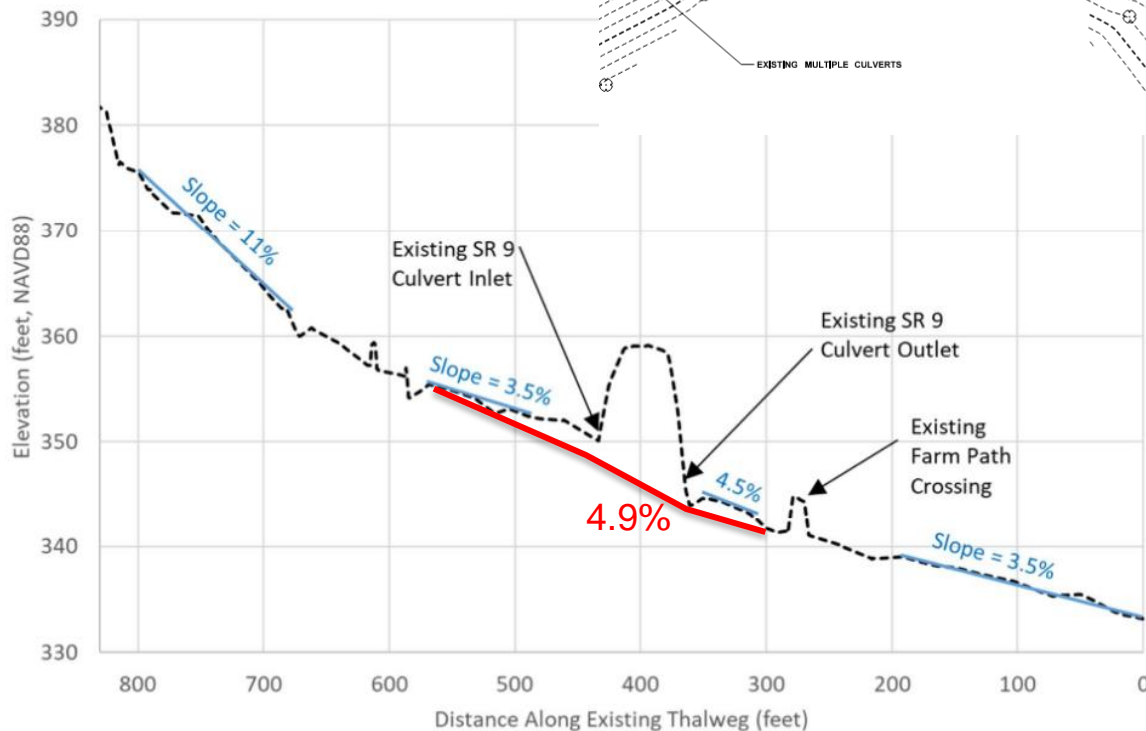
# SR 9 MP 70.60

## UNT to Landingstrip Creek #991106

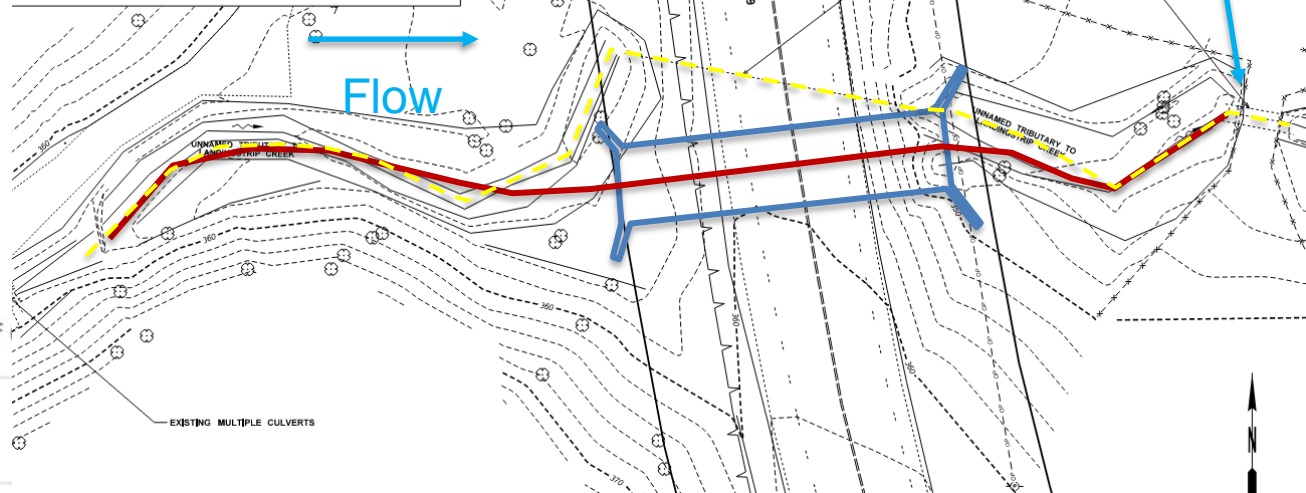


# Alignment & Profile

Longitudinal Profile in Vicinity of



- EDGE OF ROADWAY LANE
- EDGE OF ROADWAY SHOULDER
- EDGE OF PEDESTRIAN PATH
- ⊙ EXISTING TREE
- FLOW DIRECTION
- ⊙ EXISTING POWER POLE



Ex Culvert: 30 inch CMP

New Bridge by NSEA





**Reference Reach**



# Streambed Material

- Reuse of existing streambed material?

15  
16 Streambed Sediment and/or Streambed Cobbles may be available from the existing  
17 streambed excavation limits as shown in the Plans. Components of the excavated streambed  
18 which meet the criteria for the specific material may be used to supplement the Streambed  
19 Sediment and/or Streambed Cobbles and will be based upon visual acceptance by the  
20 Engineer.

21  
22 Streambed Material matching the design streambed gradation may be available from  
23 unprocessed pit run sources. Pit run sources to be reviewed for use, shall require a submittal  
24 of a sieve analysis completed within the same calendar year of placement. If the material is  
25 confirmed as a potential source, the material will be sampled and tested by the Engineer for  
26 final acceptance. Submittal of these materials for use shall be submitted before the first  
27 working day.

28



**Imported Sediment**



**Native Alluvium**





**Samples:**

Work within the wetted perimeter may only occur during the time periods authorized in the APP ID 21036 entitled "Allowable Freshwater Work Times May 2018".

Work outside of the wetted perimeter may occur year-round. APPS website:

[https://www.govonlineaas.com/WA/WDFW/Public/Client/WA\\_WDFW/Shared/Pages/Main/Login.aspx](https://www.govonlineaas.com/WA/WDFW/Public/Client/WA_WDFW/Shared/Pages/Main/Login.aspx)

Were any sample(s)  
collected from  
below the OHWM?

No ☐ If no, then stop here.

Yes ☐ If yes, then fill out the proceeding section for each sample.

Sample #:	Work Start:	Work End:	Latitude:	Longitude:
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Summary/description of location:

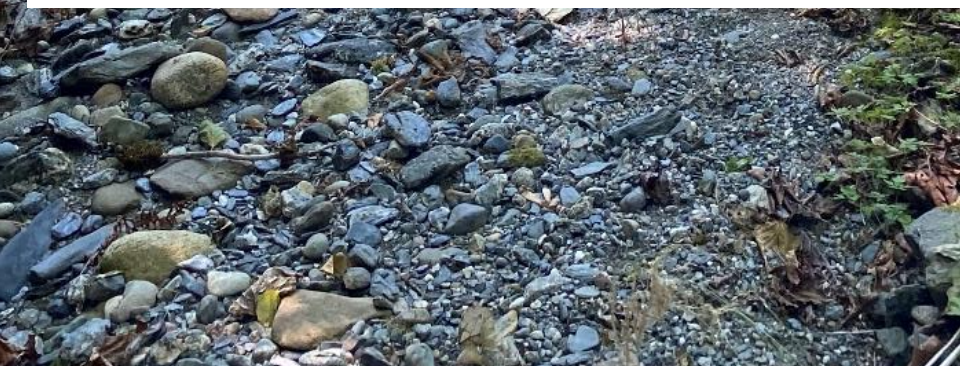
**Summarize/describe the sample location.**

Description of work below the OHWL:

*Describe the work below the OHWL, including equipment used and quantity of sediment sampled.*

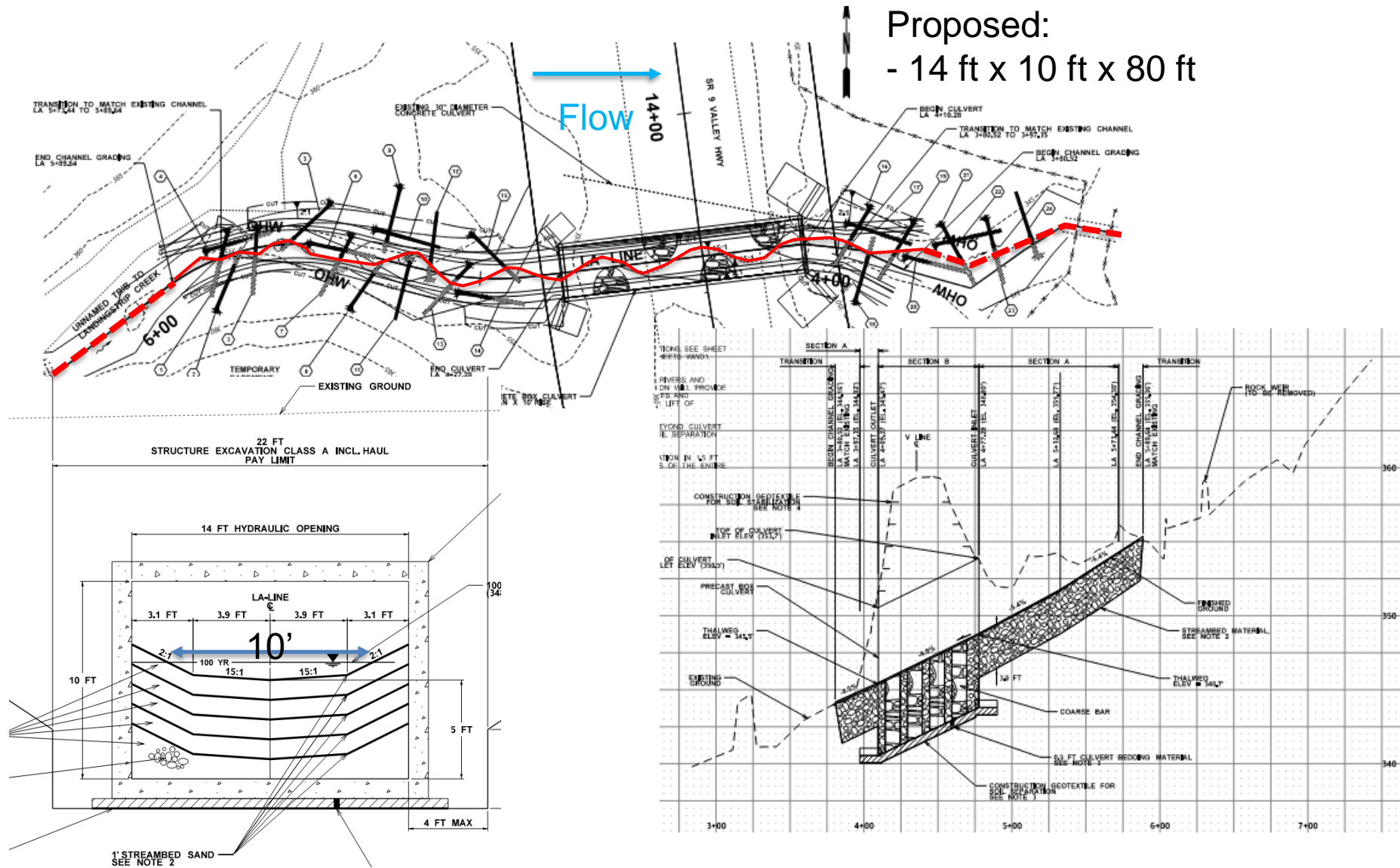
Description of problems encountered:

*Describe any problems encountered, such as provision violations, notification, corrective action, and impacts to fish life and water quality from problems that arose.*

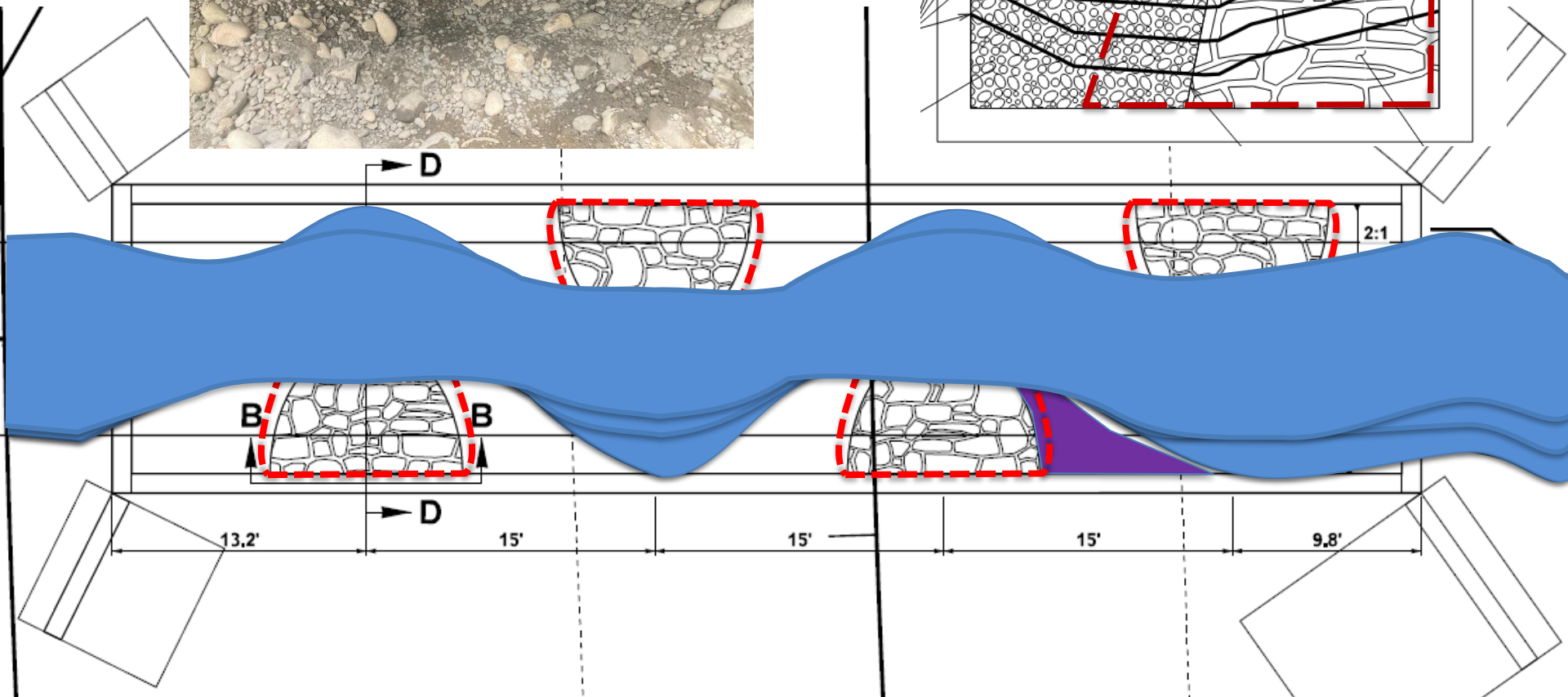
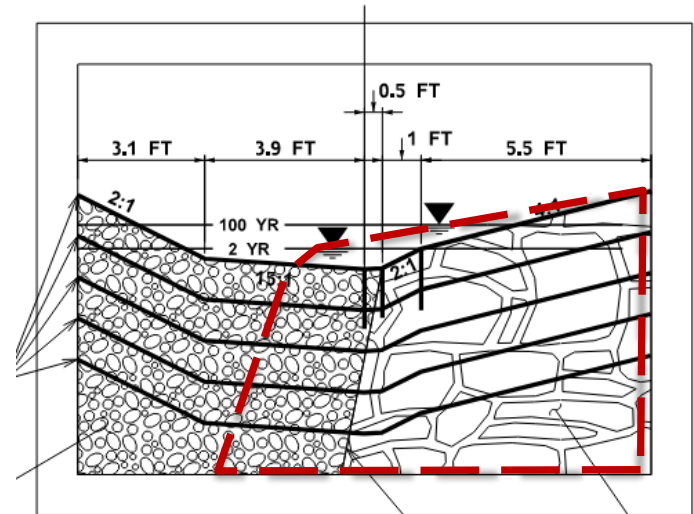




# Proposed Alignment/Profile/Section



# Streambed Geometry & Meander Bar







# Minimum Hydraulic Opening

What drives MHO?

1. **BFW – (stream simulation/confined bridge)**
2. **Velocity Ratio 1.1 – (unconfined bridge)**
3. Floodplain Connectivity
4. Lateral Migration
5. Flood Prone Width
6. Valley Width
7. Aggradation/Degradation
8. Hydraulic Backwater
9. 100yr WSE
10. Stream Sinuosity
11. Meander Amplitude
12. Channel Complexities (Boulders/LWM)
13. Model Comparison of Widths Smaller/Larger (sensitivity analysis)



# Structure Size





# Structure Size

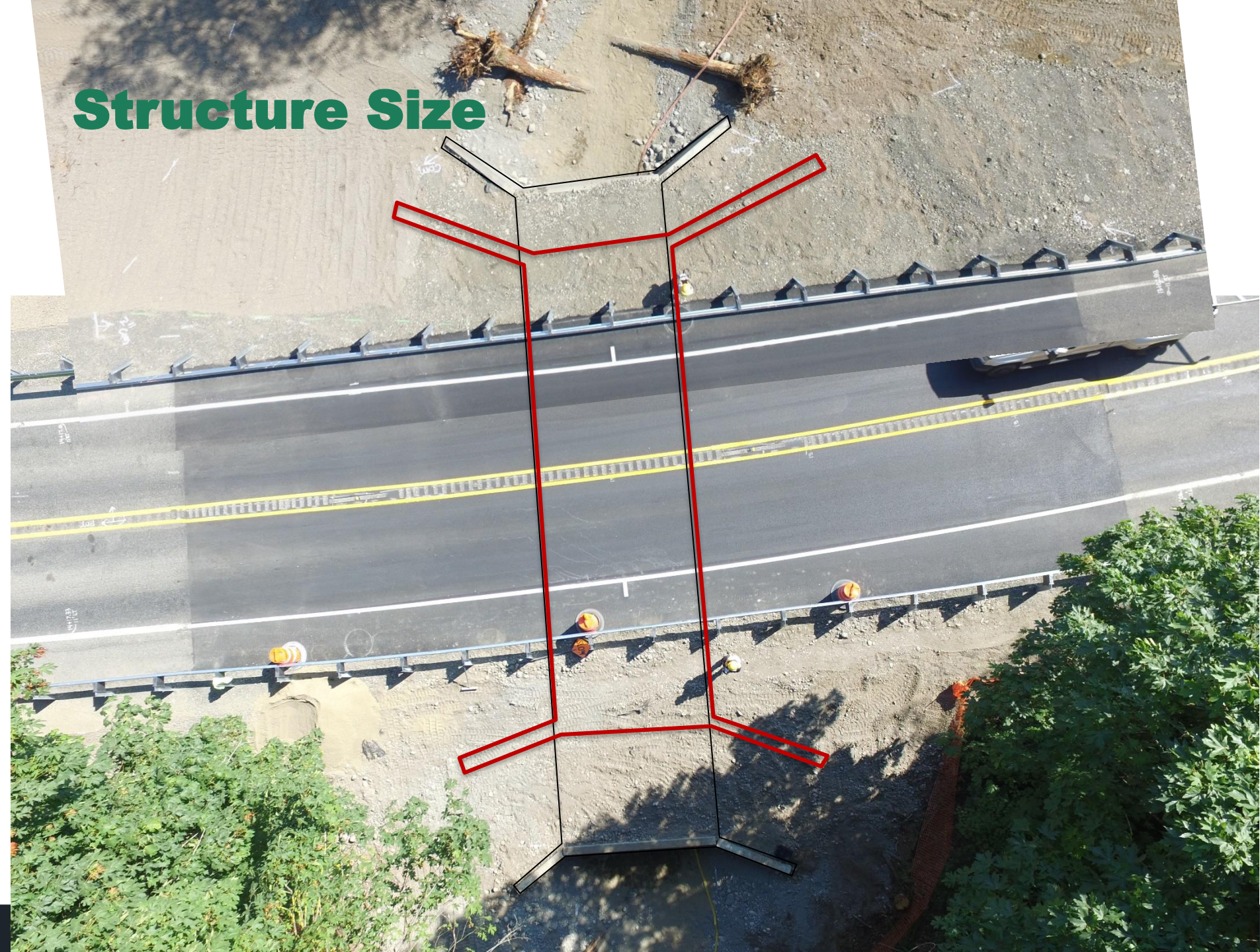
Dingos



“Micro” Excavator



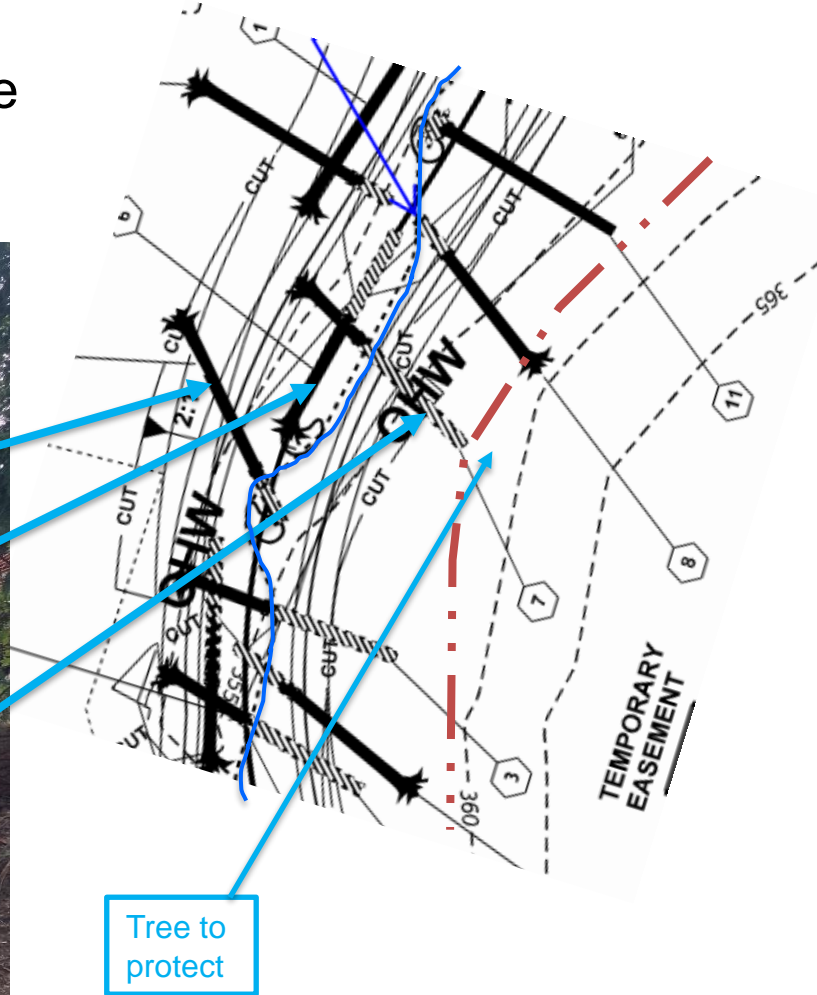
# Structure Size





# LWM Installation

- LWM not drawn to scale
- LWM typical details didn't work all the time
- Consider clearing & grubbing limits





# LWM Installation

- *Very large rootwads for channel.*



11 ft RW, 14 ft channel

Objects in the drawings may be larger than they appear



# LWM Installation















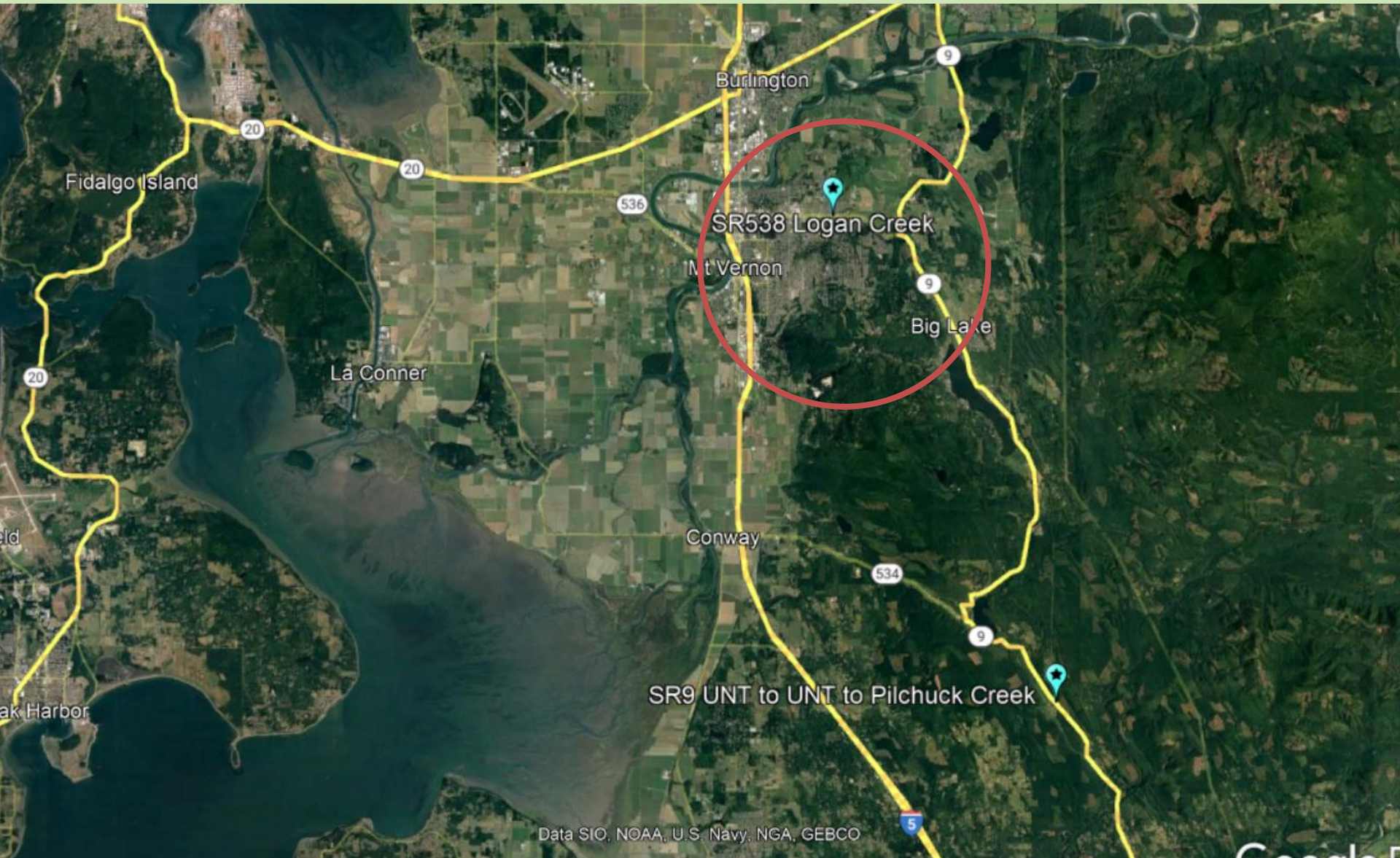


# Lessons Learned

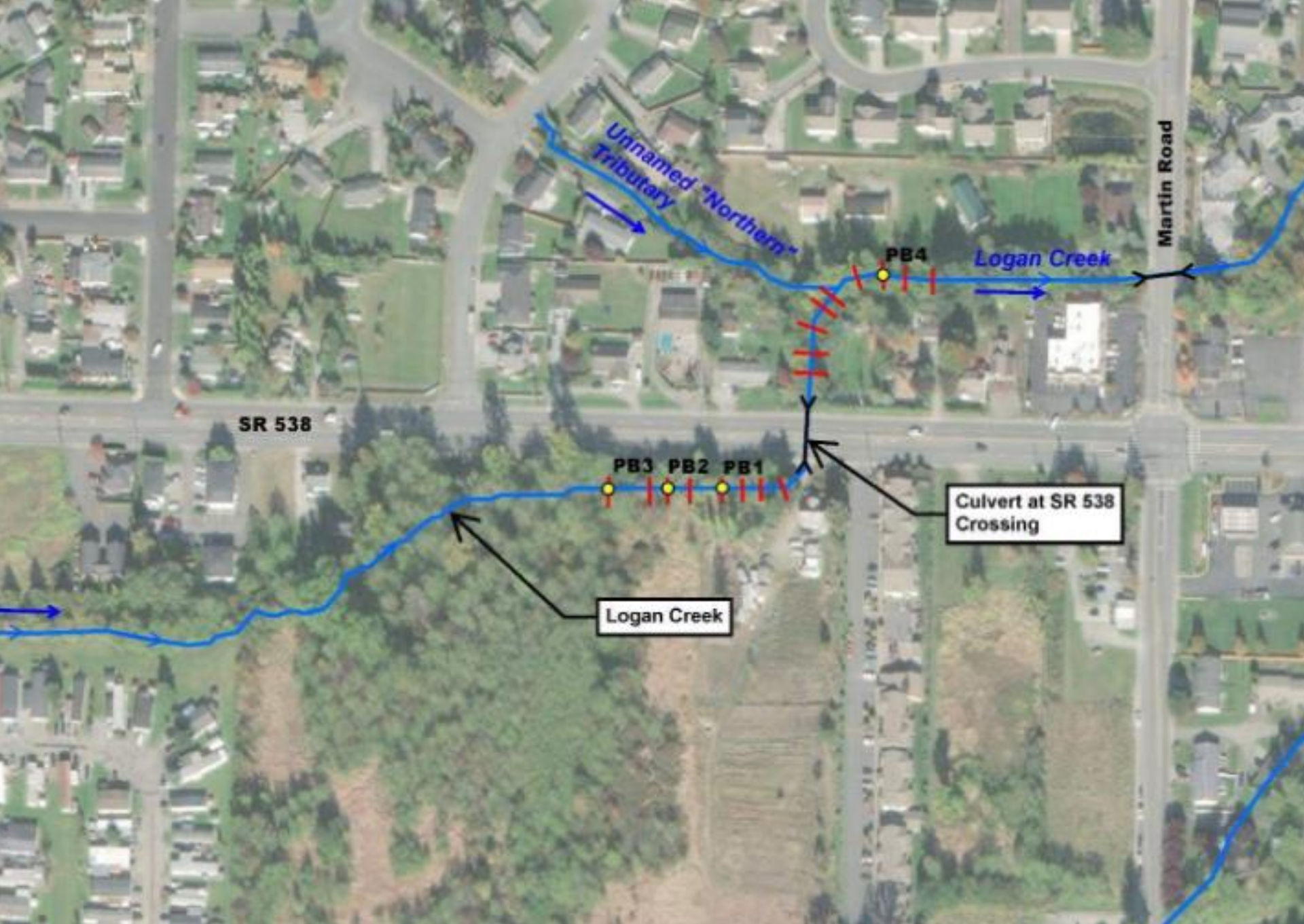
Challenges	Success	Opportunities
Downstream project tie-in	Contractor – wanted to be successful	Show LWM to scale
Limited water resources for watering in	Early start in fish window	Additional Freeboard clearance
Consider proposed condition with clearing/grubbing areas	Layering & Watering in Blended materials	Shorter crossing structure
High flows before bank stabilization	Good LWM design & details	Extension of Meander Bars
	Added Meander Bar in the field	Coarser Meander Bars
		Better coordination with downstream project

# SR 538 MP 2.18

## Logan Creek #NC129

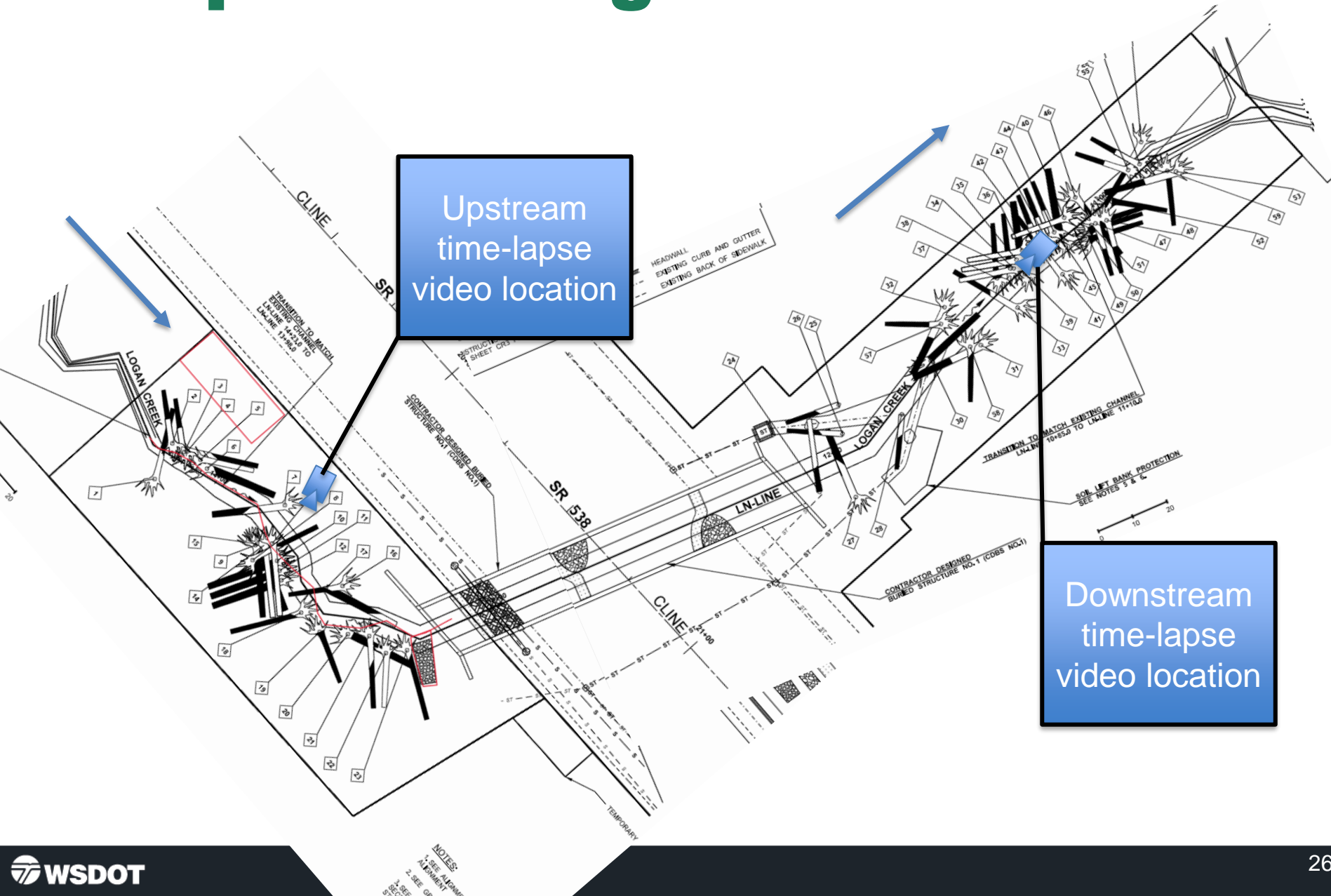








# Proposed Design





# Proposed Design

LARGE WOODY MATERIAL (LWM) LOCATION TABLE											
SHEET NO.	LWM NO.	TYPE	MIN. LENGTH (FT)	DIAM. (INCHES)	ROOTWAD (Y/N)	STATION/OFFSET	ANGLE A (DEG.)	ANGLE B (DEG.)	DISTANCE C (FT) (SEE NOTE 1)	DISTANCE D (FT)	LOGS LOCATED ABOVE
CR1	1	B	20	18-24	Y	LN 14+15 (8RT)	120	115	4.4	6.5	2, 3
CR1	2	C	15	18-24	Y	LN 14+18 (3RT)	-45	105	-1.0	13.5	
CR1	3	C	15	18-24	Y	LN 14+12 (3RT)	-45	105	-1.0	13.5	
CR1	4	B	20	18-24	Y	LN 14+11 (3LT)	-160	110	5.0	8.5	5
CR1	5	C	15	18-24	Y	LN 14+07 (3RT)	-160	99	1.0	7.5	
CR1	6	A	20	24-30	Y	LN 14+04 (2RT)	-179	110	7.4	0.5	8
CR1	7	A	20	24-30	Y	LN 13+62 (6RT)	-135	120	6.7	8.5	
CR1	8	B	20	18-24	Y	LN 13+16 (10LT)	80	125	5.2	8.5	13
CR1	9	A	20	24-30	Y	LN 13+79 (7LT)					
CR1	10	A	20	24-30	Y	LN 13+72 (5LT)					
CR1	11	A	20	24-30	Y	LN 13+66 (5LT)					
CR1	12	A	20	24-30	Y	LN 13+63 (5LT)					
CR1	13	B	20	18-24	Y	LN 13+76 (3LT)					
CR1	14	C	15	18-24	Y	LN 13+77 (5LT)					
CR1	15	A	20	24-30	Y	LN 13+79 (7LT)					
CR1	16	C	15	18-24	Y	LN 13+47 (6RT)					
CR1	17	A	20	24-30	N	LN 13+57 (5RT)					
CR1	18	B	20	18-24	Y	LN 13+55 (5LT)					
CR1	19	C	15	18-24	Y	LN 13+52 (5LT)					
CR1	20	A	20	24-30	Y	LN 13+44 (5LT)					
CR1	21	B	20	18-24	Y	LN 13+38 (4LT)					
CR1	22	C	15	18-24	Y	LN 13+31 (7LT)					
CR1	23	B	20	18-24	Y	LN 13+25 (4LT)					

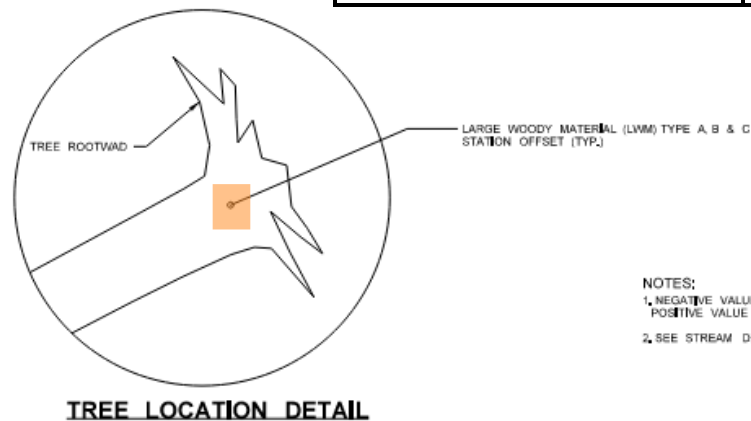
LARGE WOODY MATERIAL (LWD) TABLE

TYPE A

TYPE B

LARGE WOODY DEBRIS (LWD) TOTALS	
TYPE A	16
TYPE B	12
TYPE C	31
3-MAN BOULDER	2

LARGE WOODY MATERIAL (LWM) LOCATION TABLE											
SHEET NO.	LWM NO.	TYPE	MIN. LENGTH	DIAM.	ROOTWAD (Y/N)	STATION/ OFFSET	ANGLE A (DEG.)	ANGLE B (DEG.)	DISTANCE C (FT) (SEE NOTE 1)	DISTANCE D (FT)	LOGS LOCATED ABOVE
CR2	24	B	20	18-24	N	LN 12+07 (6LT)	-120	108	-3.4	9.0	
CR2	25	C	15	18-24	N	LN 11+86 (13RT)	165	115	-3.9	0.0	
CR2	26	C	15	18-24	N	LN 11+95 (6RT)	-165	115	-3.9	0.0	
CR2	27	A	20	24-30	Y	LN 11+99 (12LT)	90	115	-3.8	6.5	
CR2	28	C	15	18-24	N	LN 11+80 (6LT)	-165	115	-3.9	0.0	
CR2	30	A	20	24-30	Y	LN 11+62 (1RT)	-180	110	-7.4	0.5	
CR2	31	A	20	24-30	Y	LN 11+50 (5LT)	160	115	-5.8	0.0	30, 58
CR2	32	A	20	24-30	Y	LN 11+49 (6RT)	-160	115	-5.8	0.0	30, 57
DEBRIS TOTALS						+36 (6LT)	110	115	-4.4	6.5	34, 35, 36
						+29 (2RT)	-45	100	1.5	12.5	
						+27 (3RT)	-45	100	1.5	12.5	
						+24 (4RT)	-45	100	1.5	12.5	
						+34 (3RT)	-130	100	-2.5	14.5	34, 35, 36
						+30 (3RT)	-130	100	-2.5	14.5	34, 35, 36
						+28 (1LT)	-130	100	-2.5	19.5	34, 35, 39, 40
						+10 (4RT)	-25	95	2.5	9.5	
						+20 (8LT)	90	115	-5.4	9.5	36, 40
						+20 (9RT)	-110	100	0.5	18.5	40
						+17 (3RT)	-110	100	0.5	18.5	40
						+15 (3RT)	-110	100	0.5	18.5	40
						+15 (1LT)	-130	100	-2.5	19.5	40
						+04 (6RT)	-90	115	-5.4	9.5	47, 48, 49, 50, 51
						+05 (3LT)	65	105	-0.4	15.0	
						+02 (4LT)	65	105	-0.4	15.0	
						+09 (5LT)	160	110	-3.4	7.5	47, 48
						+07 (3LT)	160	110	-3.4	7.5	47, 48, 52
					+06 (2LT)	160	110	-3.4	7.5	47, 48, 52	
					+98 (1LT)	135	105	-1.4	14.5		
					+78 (6LT)	160	115	-5.8	0.0		
					+81 (6RT)	-155	110	-4.4	0.5	55, 56	
CR2	55	C	15	18-24	Y	LN 10+89 (2RT)	-65	105	-0.4	15.0	
CR2	56	C	15	18-24	Y	LN 10+85 (2RT)	-65	105	-0.4	15.0	
CR2	57	C	15	18-24	Y	LN 11+53 (5RT)	-45	115	-2.4	13.5	
CR2	58	C	15	18-24	Y	LN 11+52 (5LT)	45	115	-2.4	13.5	
CR2	59	C	15	18-24	Y	LN 10+80 (5LT)	45	115	-2.4	13.5	



NOTES:  
 1. NEGATIVE VALUE INDICATES DEPTH BENEATH THALWEG  
 POSITIVE VALUE INDICATES DEPTH ABOVE THALWEG  
 2. SEE STREAM DETAILS SHEETS FOR LWM DETAILS

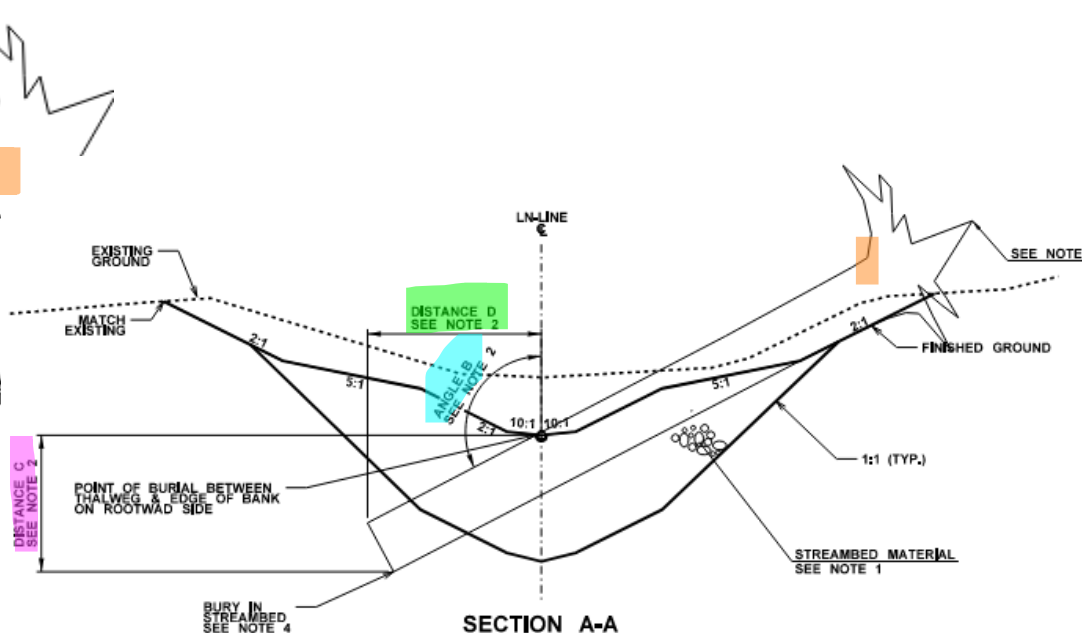
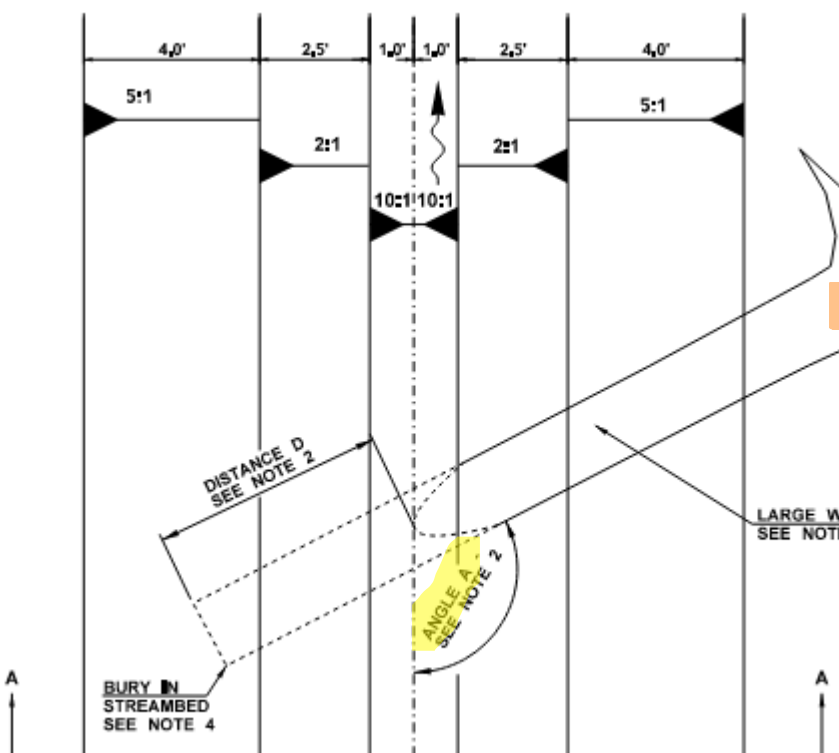
LARGE WOODY DEBRIS (LWD) TOTALS	
TYPE A	16
TYPE B	12
TYPE C	31
3-MAN BOULDER	2



# Proposed Design

## LARGE WOODY MATERIAL (LWM) LOCATION TABLE

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CR1	1	B	20	18-24	Y	LN 14+15 (8'RT)	120	115	-4.4	6.5	2, 3
CR1	2	C	15	18-24	Y	LN 14+18 (3'RT)	-45	105	-1.0	13.5	
CR1	3	C	15	18-24	Y	LN 14+12 (3'RT)	-45	105	-1.0	13.5	
CR1	4	B	20	18-24	Y	LN 14+11 (3'LT)	-160	110	-5.0	8.5	5
CR1	5	C	15	18-24	Y	LN 14+07 (3'RT)	-160	90	2.0	7.5	



## LARGE WOODY MATERIAL (LWM) TYPE A, B OR C



# LWM Installation





# LWM Installation





# LWM Installation





# Blended Streambed Material



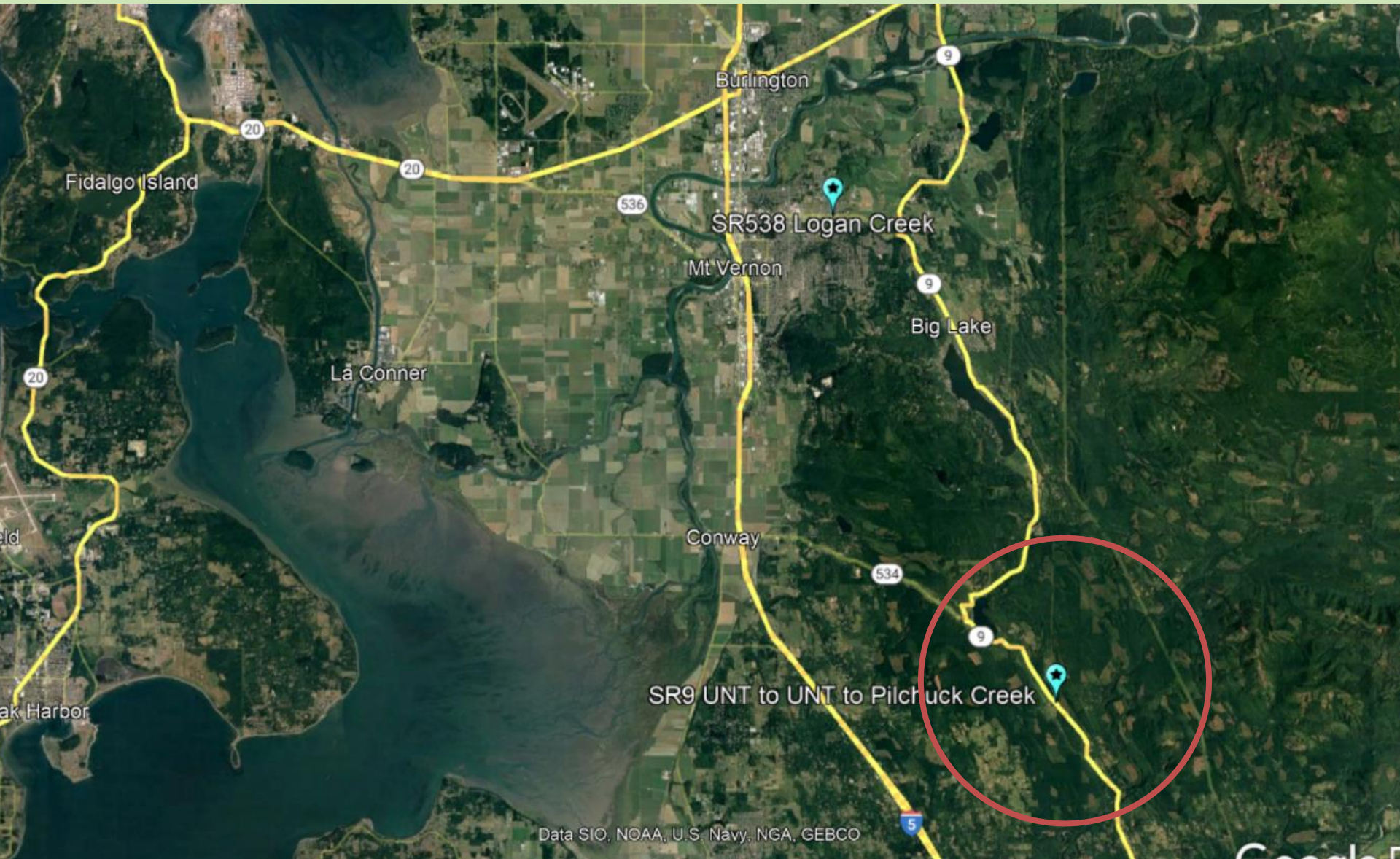
Streambed Material shall be a mix of the following aggregates with the following percentages as called out in the plans:

Streambed Material	
Streambed Sediment:	60%, by volume
Streambed Cobbles 4 In.:	40%, by volume



**SR 9 MP 37.3**

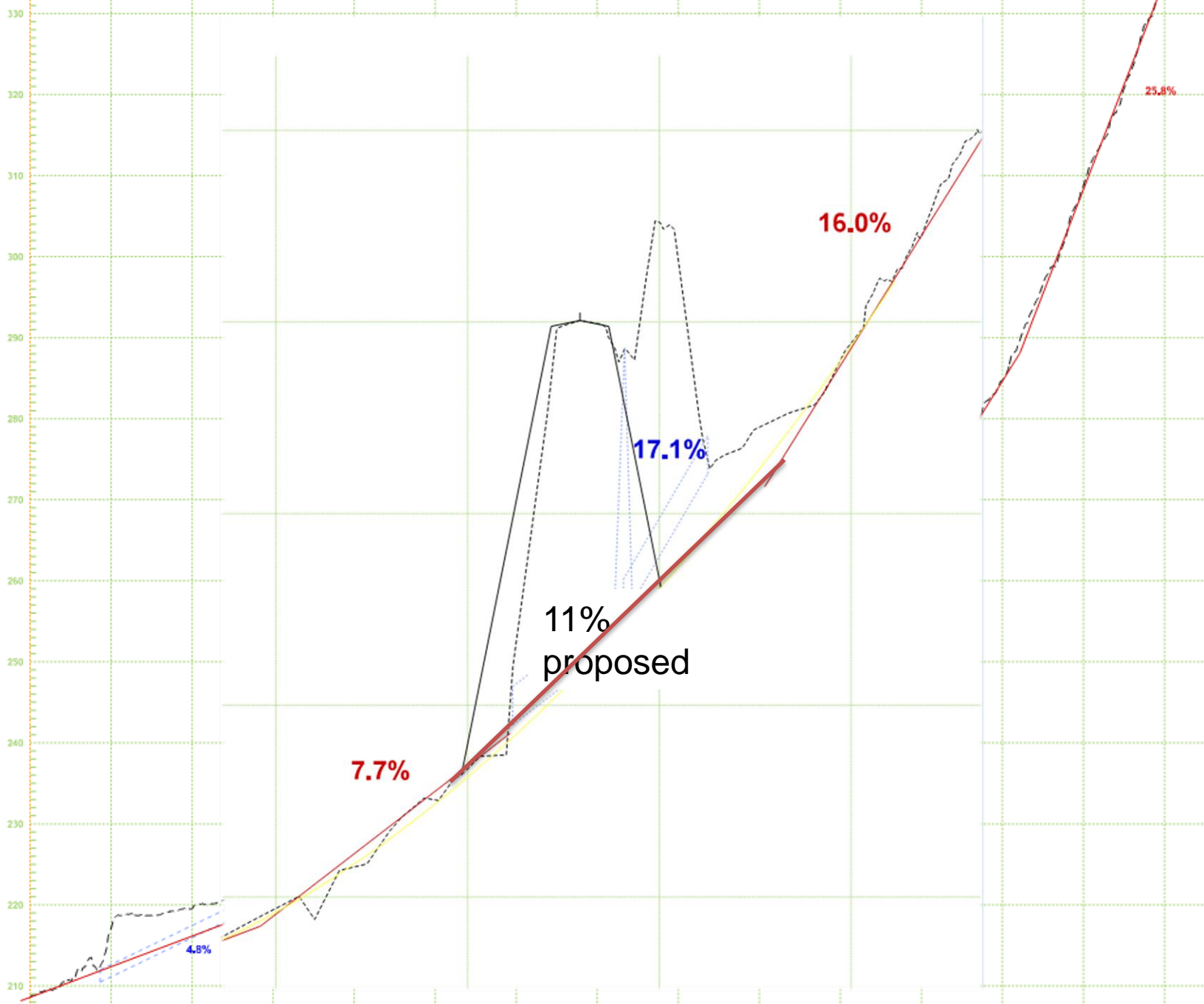
**UNT to Pilchuck Creek (WDFW #LP19)**





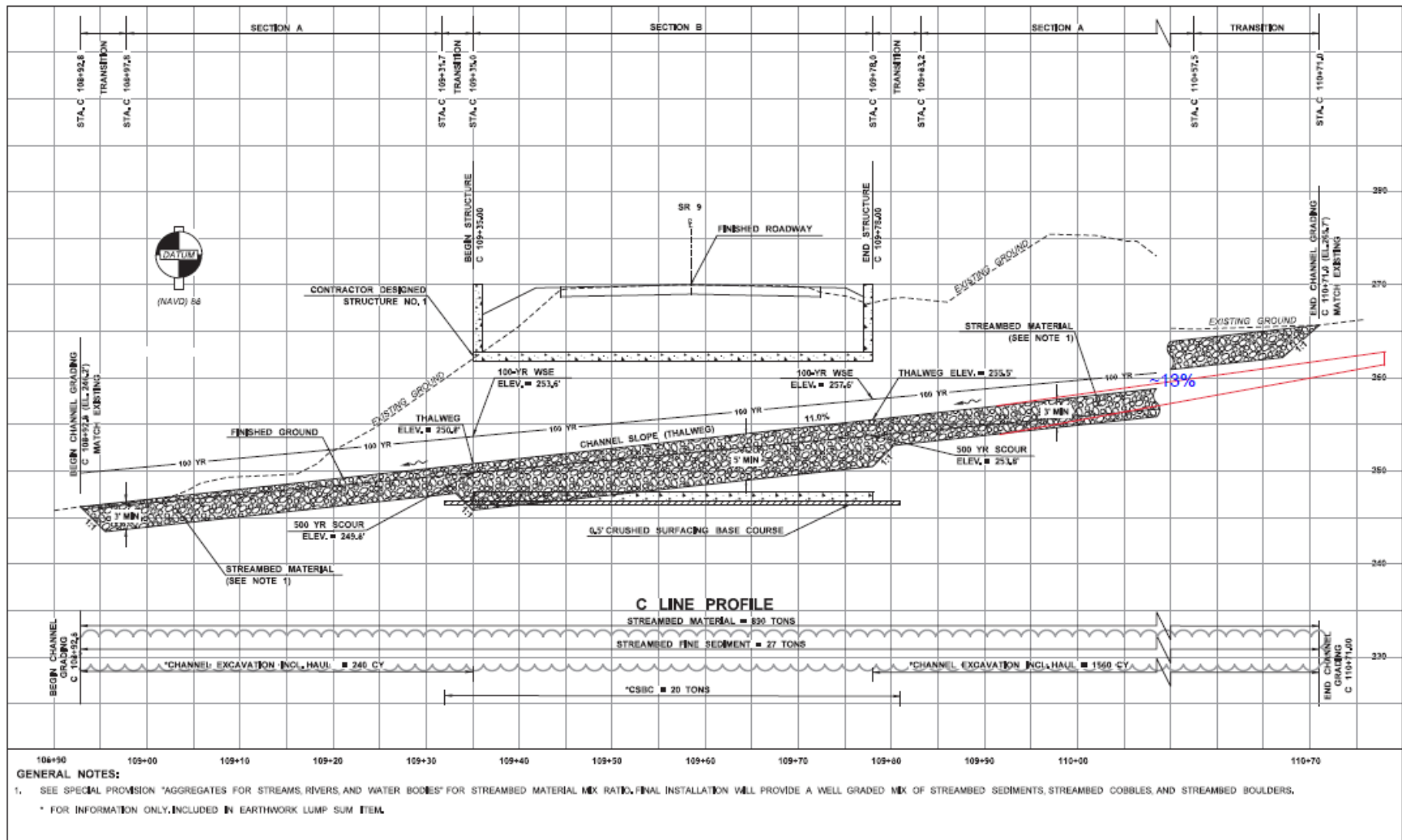






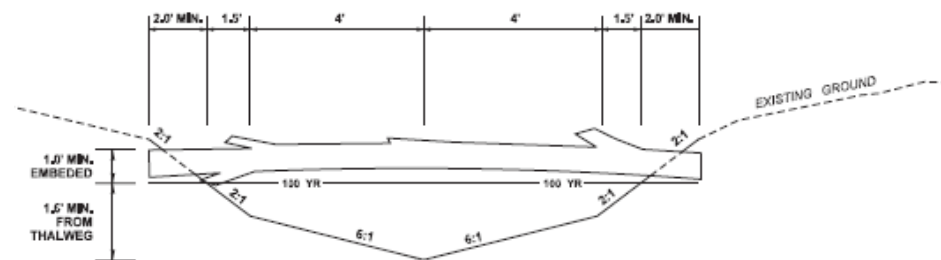
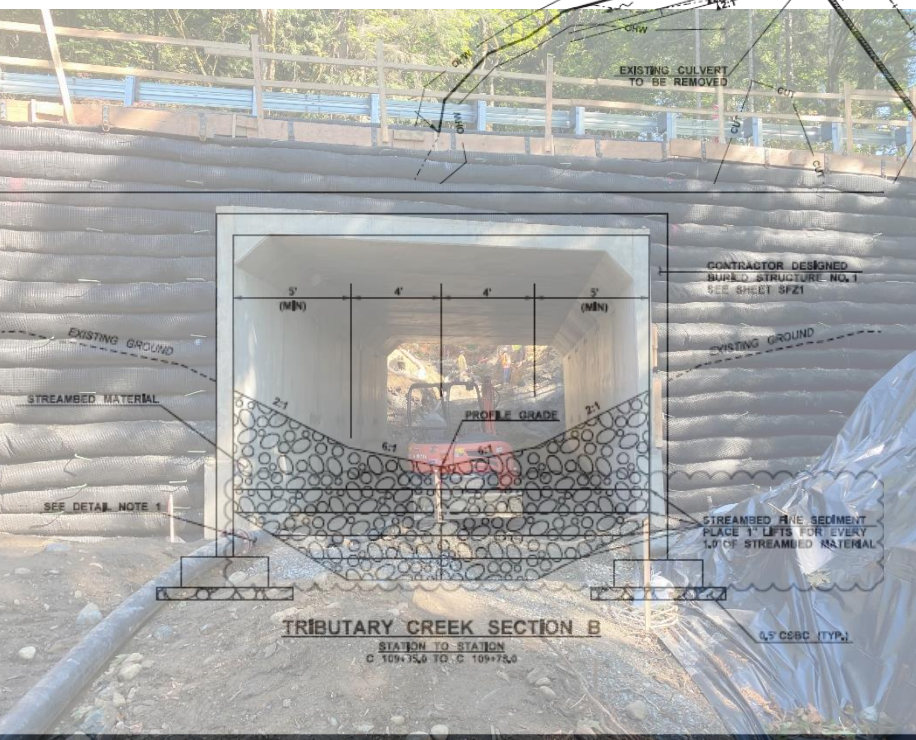
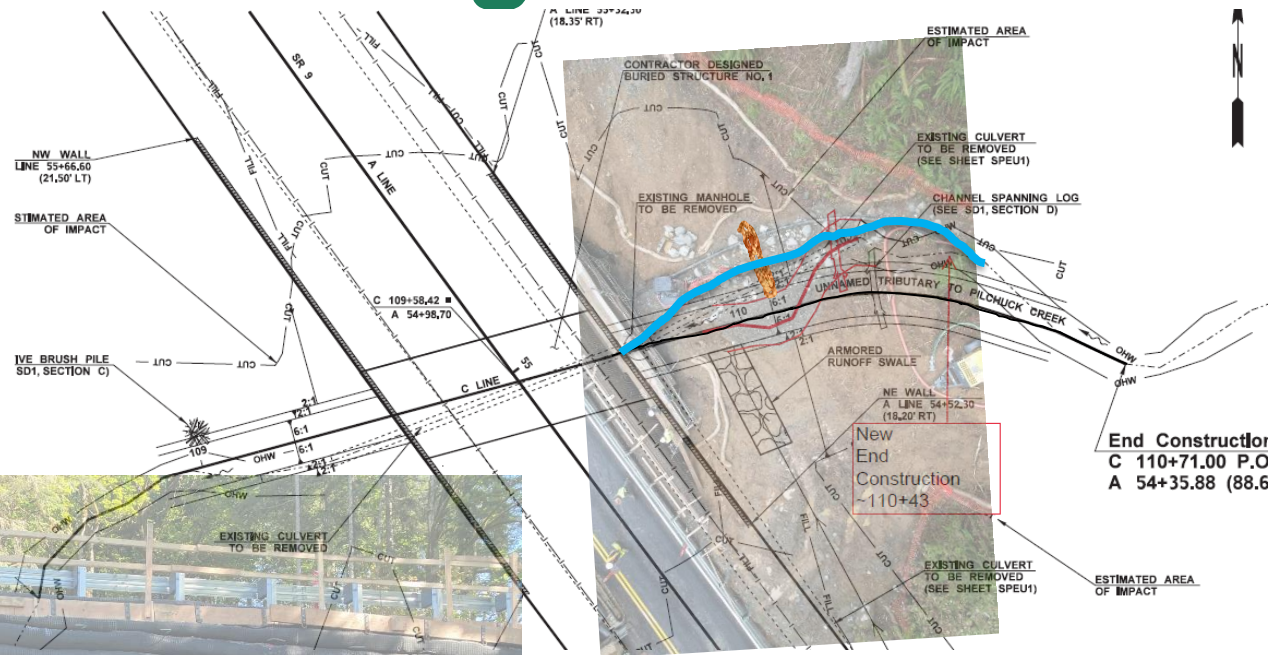


# Proposed Design





# Proposed Design



### CHANNEL SPANNING LOG DETAIL SECTION D

APPROXIMATE STATION C 110+11.0±  
OR AS DIRECTED BY ENGINEER



# Construction





# Blended Streambed Material



## **Streambed Material**

Streambed Sediment:	30%, by volume
Streambed Cobbles 12 IN.:	24%, by volume
Streambed Boulders One Man:	23%, by volume
Streambed Boulders Two Man:	23%, by volume



# Streambed Materials

## 9-03.11(1) Streambed Sediment

Streambed sediment shall meet the following requirements for grading when placed in hauling vehicles for delivery to the project or during manufacture and placement into temporary stockpile. Alternate gradations may be used if proposed by the Contractor and accepted by the Engineer. The Contractor shall submit a Type 2 Working Drawing

## 9-03.11(2) Streambed Cobbles

The grading of the cobbles shall be determined by the Engineer by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load.



**Native Alluvium**

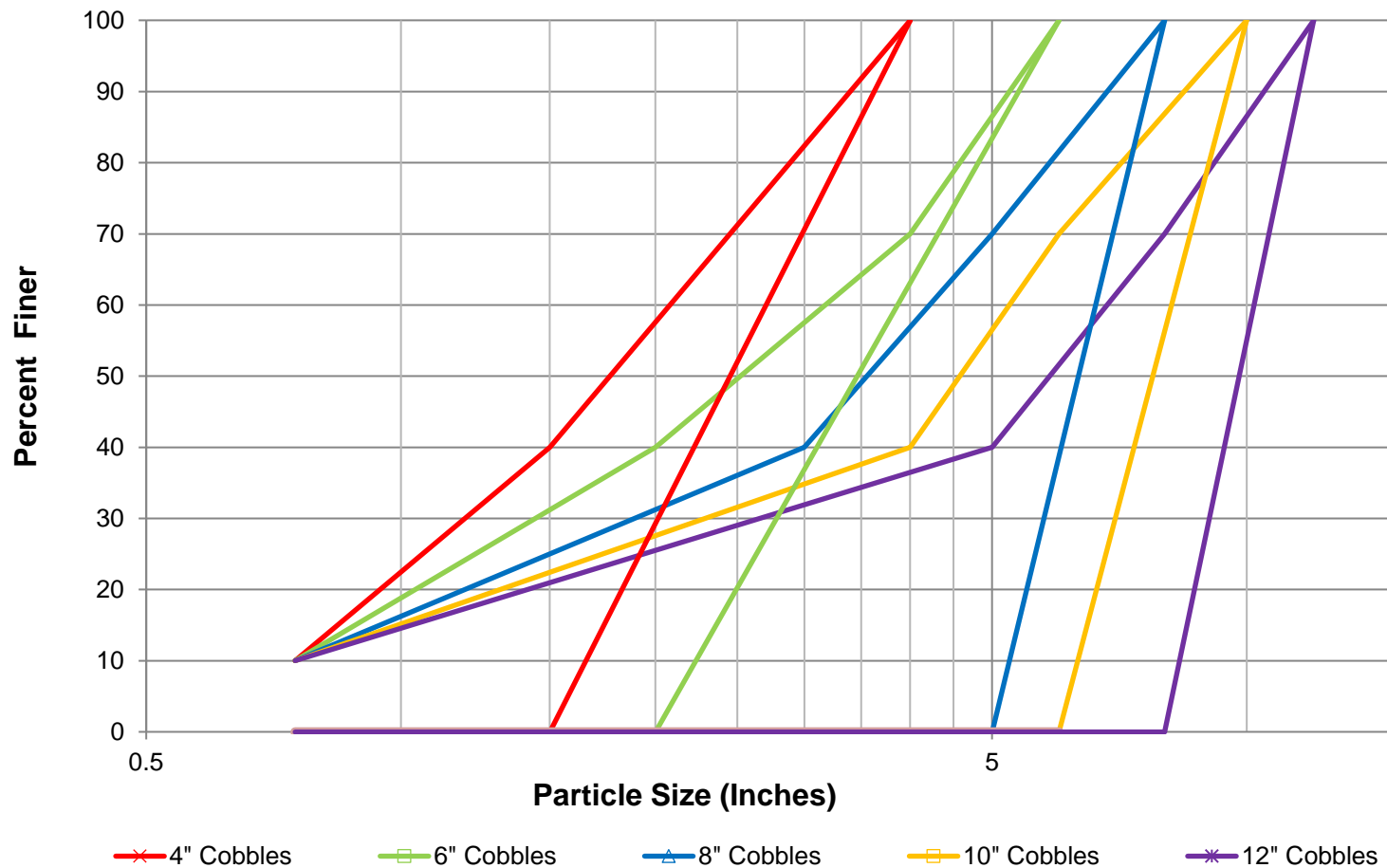


**Imported Sediment**



# Streambed Mixes

Standard Specification 9-03.11(2)



4" Cobbles

6" Cobbles

8" Cobbles

10" Cobbles

12" Cobbles



# Streambed Material

Streambed Material shall be a mix of the following aggregates with the associated ratios, as called out in the plans:

## Streambed Material

Streambed Sediment:

50%, by volume

Streambed Cobbles 6 In.:

50%, by volume

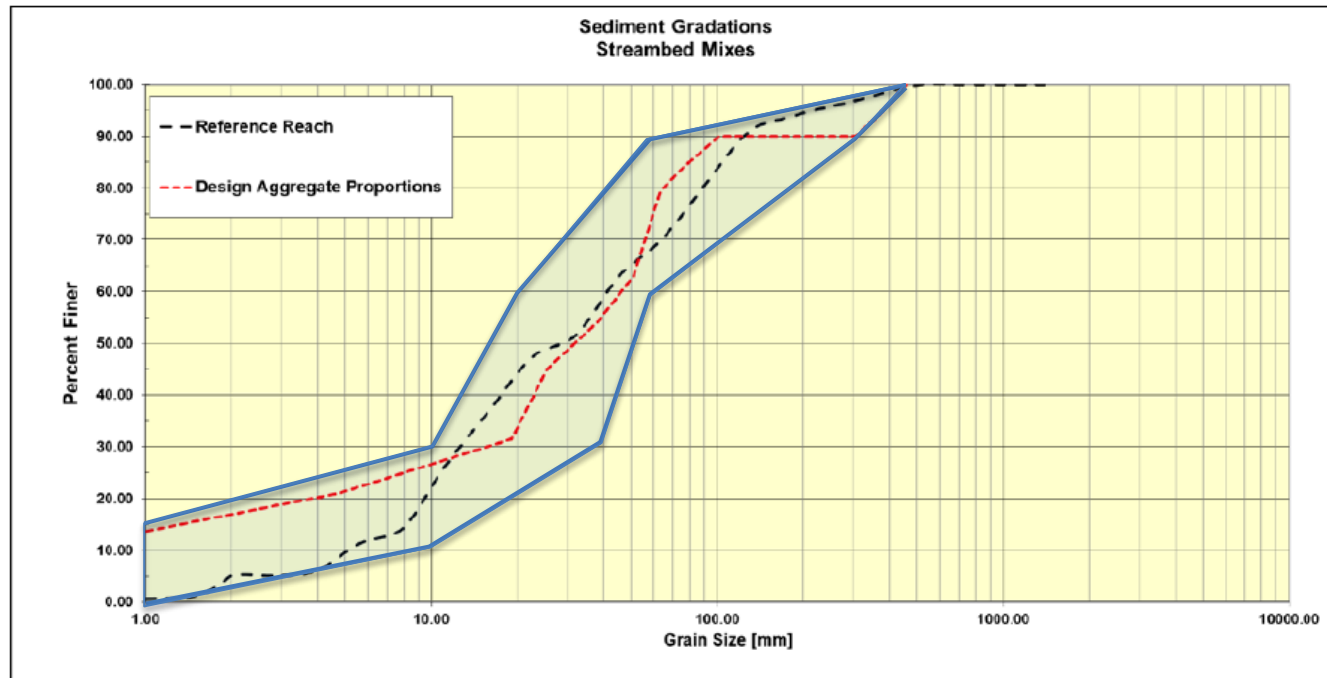


Figure 42 Proposed Sediment Gradation



# Streambed Sediment





# Three-Man (Type 3)





# Construction





# Construction





# Lessons Learned

Challenges	Success	Opportunities
Contractor – Not in it to win it	Steep Step-Pool Bed Design	More LWM and MWM
Communication – PEO to Contractor to HQ	Good team work once initiated	Increase structure height
Contractor - Unsure how to execute, lack urgency	Mixing and placement of material	Minimized impact – US grading and slope grading
Schedule uncertainty – extension of fish window	Layering & Watering in Blended materials & Boulders	
Survey - bust		
TSD Plan		



# Placing Streambed Material

## *Placement of Aggregates for Streams, Rivers, and Waterbodies*

### **Stockpiling Aggregate**

Streambed Sediment and Streambed Cobbles as described above, shall be blended into single well graded stockpiles separate from other aggregates.

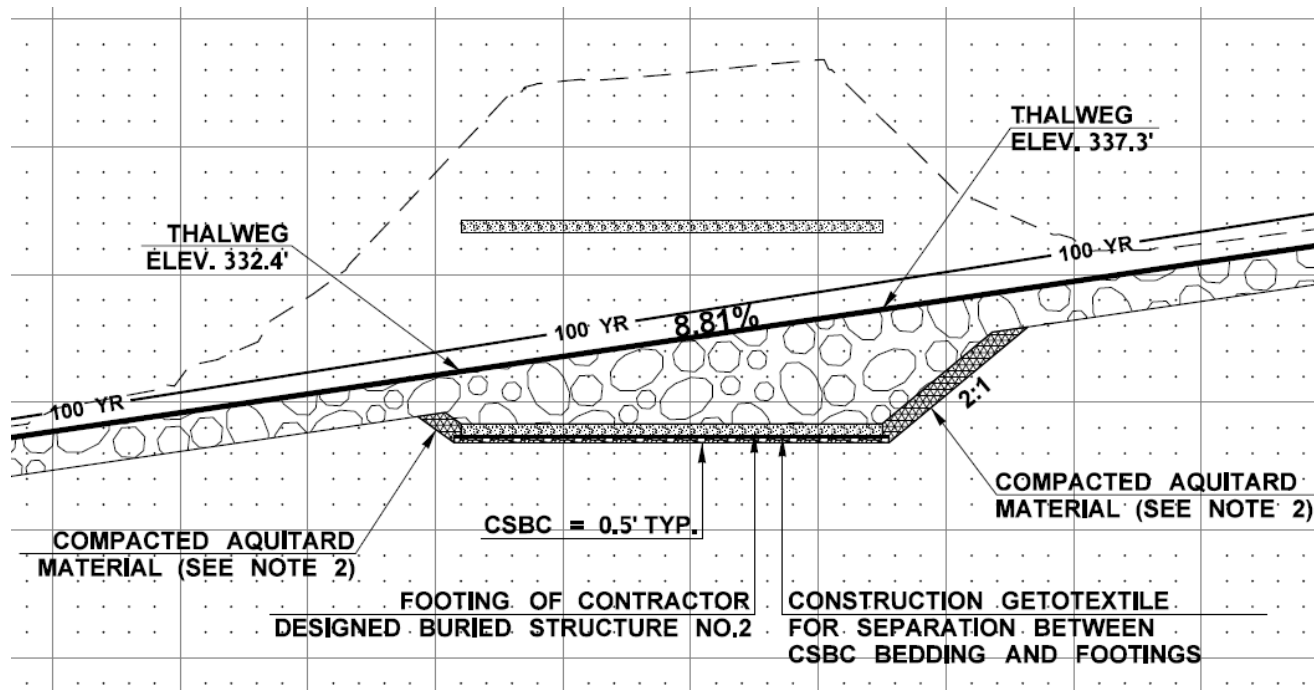
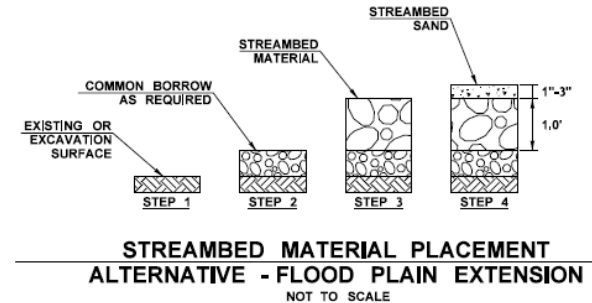
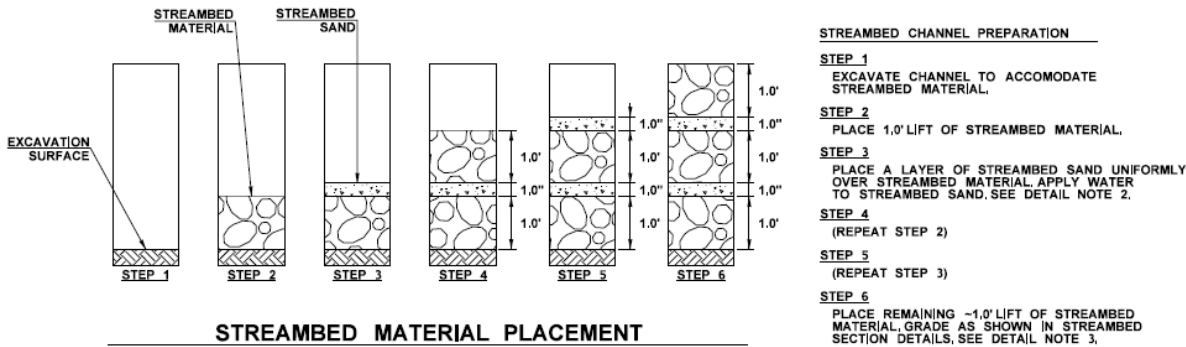
### **Placing Aggregate in Streambed**

Streambed Material shall be placed in the prepared channel excavation to the lines and grades shown on the Plans and in such a way as to prevent material segregation. Streambed Material shall be placed in lifts no thicker than 12 inches. Streambed Material in its final location shall be a well graded mix.

Placement of Streambed Material shall be constructed to ensure that stream low flow rate of 30 gallons per minute, or as determined by the Engineer, is conveyed above each lift. The Contractor shall apply water and 1-inch depth of Streambed Sand to each lift to facilitate filling the interstitial voids of the Streambed Materials. The voids are satisfactorily filled when water equivalent to the low flow rate of the stream does not go subsurface and there is no perceivable difference in the low flow rate from upstream of the project limits to the downstream of project limits. The Contractor shall apply water at the low flow rate to the stream channel for visual acceptance by the Engineer. Water shall be free from contaminants, chlorination and any additive that has a risk on fish and other ecological life.



# Placing Streambed Material





# Streambed Sand





# Sealing the Bed





# Sealing the Bed





# Sealing the Bed





# Sealing the Bed





# Sealing the Bed





# Entrainment





# Plane bed





# Channel Complexities

- Coarse bands
- Meander bars
- Boulder clusters
- Large Woody Material
- Deformable Grade Control



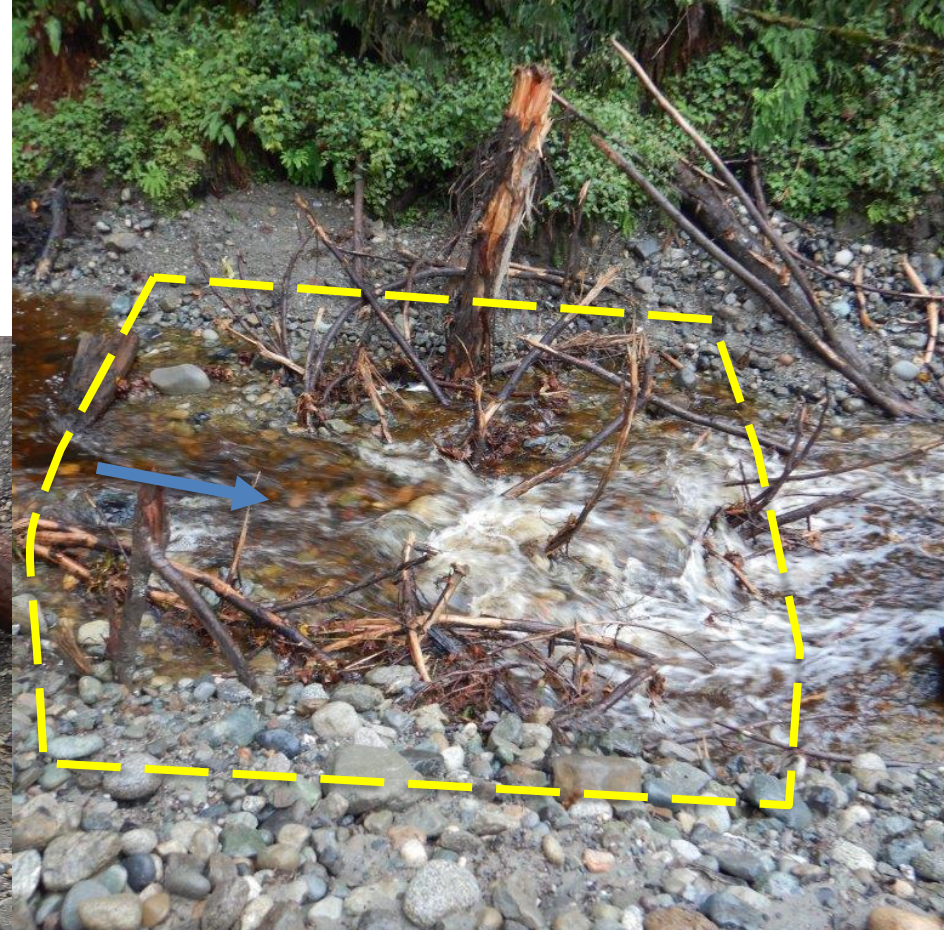
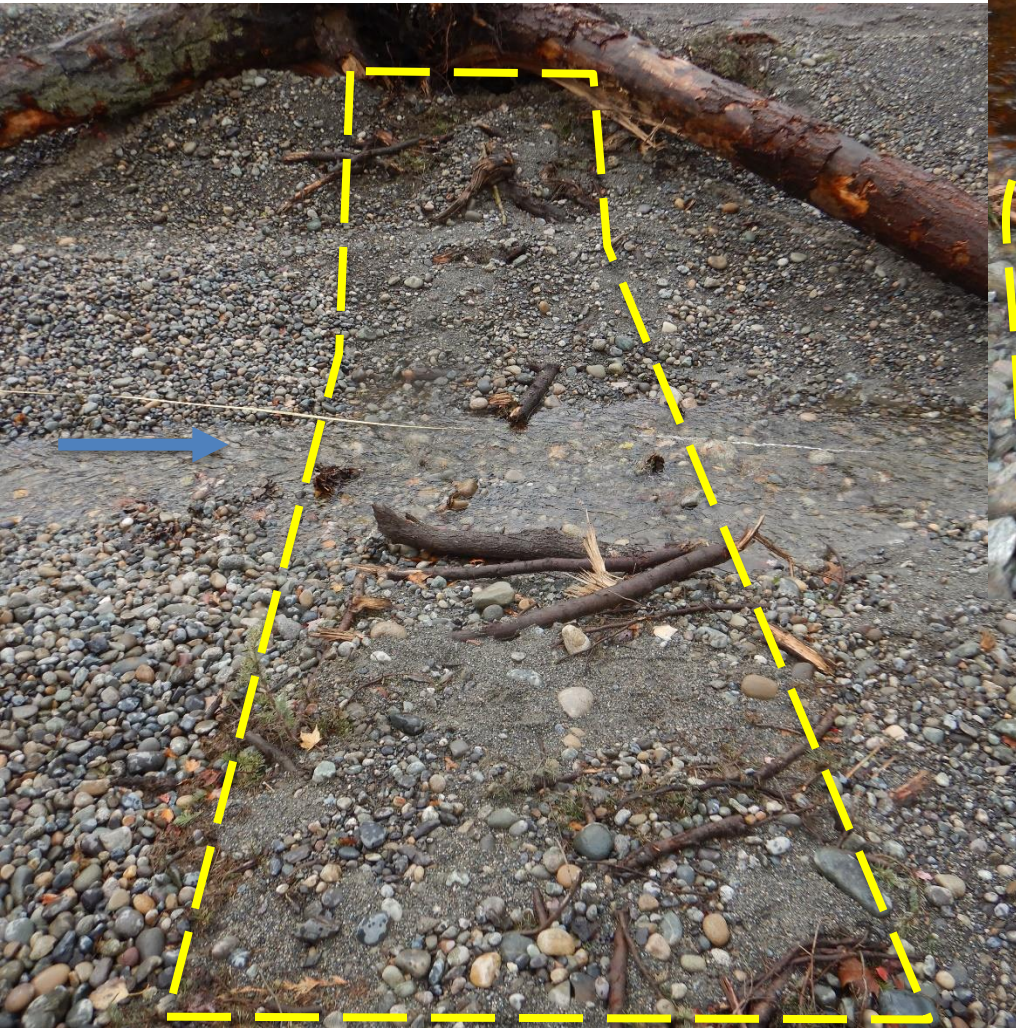


# Meander Bars & Boulder Clusters





# Deformable Grade Controls





# Structure Scour

## Local Scour

- Boulders
- Large Woody Material
- Deflection





# Bank Stabilization

- Transition
  - Margins
  - Plant establishment
    - Coir mats/wraps
    - Willow plantings
    - Staking





# Large Woody Material

## *Onsite Evaluation Meeting*

**An onsite evaluation meeting shall be held at least** held at least 3 working days prior to the reintroduction of flows into the new channel or removal of the temporary stream diversion, whichever occurs first.

Those attending shall include:

1. Contractor: The superintendent, on site supervisor, foreman, the Environmental Compliance Lead and any other personnel that will have on-site responsibility for in-channel streambed Work.
1. WSDOT: The WSDOT Engineer, key inspection personnel, Region Environmental, Headquarters Hydraulics and Headquarters Environmental Service Office (Fish Passage Biologist & Monitoring Program Lead).
1. Representatives from interested permitting agencies (WDFW) and affected Tribes shall be invited by WSDOT.

The Contractor shall provide notice to the Engineer 14 calendar days prior to this meeting taking place.

The meeting will evaluate and discuss the streambed installation and large woody material placement to ensure the streambed will performing as intended. As a result of the onsite evaluation meeting, modifications to the streambed materials, features or large woody materials may be made by the Engineer.



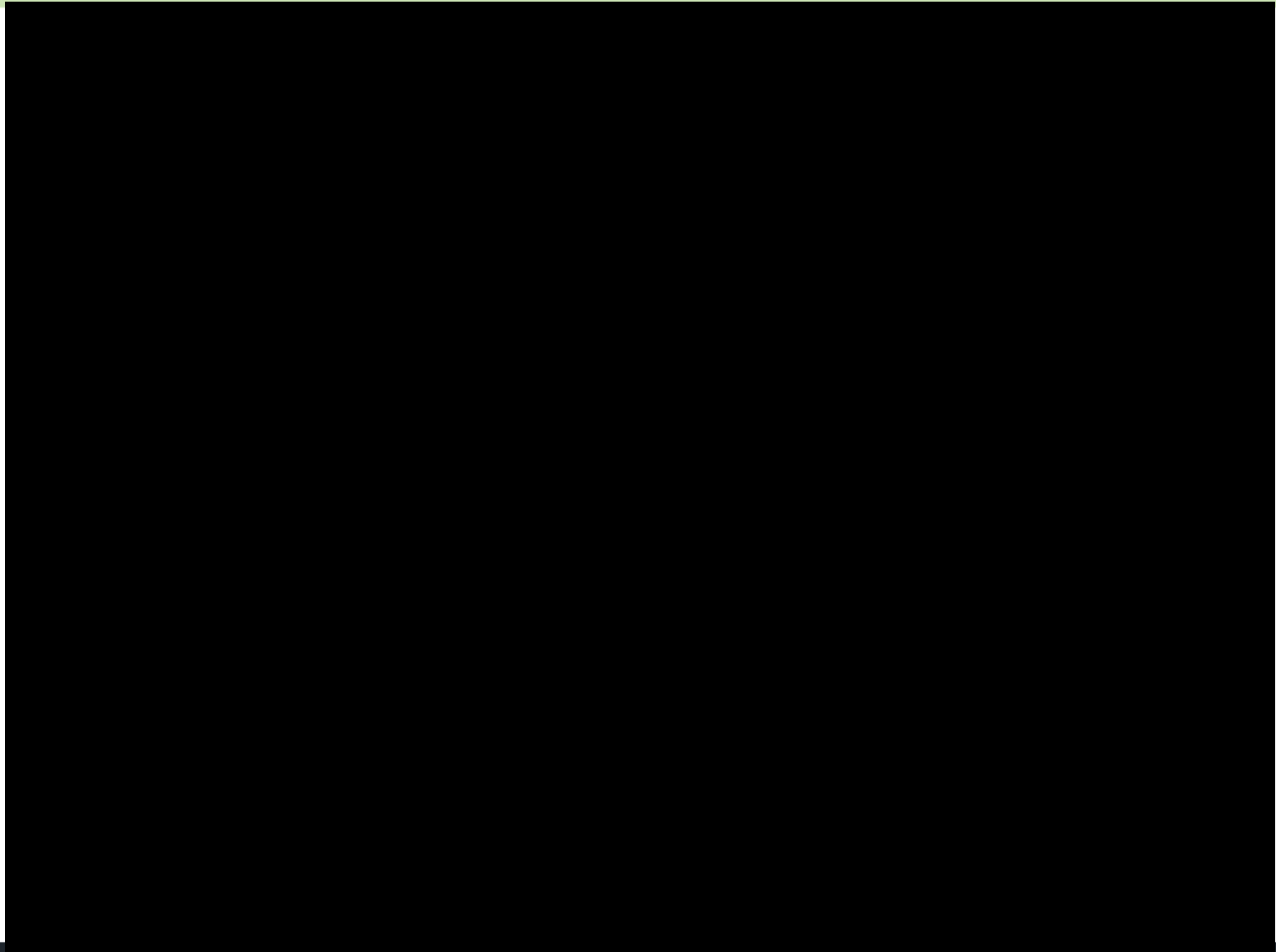
# SR 20 MP 88.82

## Lorenzan Creek (WDFW GR23)





**SR 20 MP 87.82**  
**Fish Creek (WDFW ID #GR9)**





# Additional Information



- Final Hydraulic Design Report (link in Special Provisions)
- HQ site inspection
- Just-In-Time (JIT) Training – hosted annually
- WSDOT Fish Passage Training Certification
  - [Hydraulics & hydrology training | WSDOT \(wa.gov\)](#)
- WSDOT Certified Inspector Training – March 2022
- Me [nggabe@wsdot.wa.gov](mailto:nggabe@wsdot.wa.gov) or [gabe.ng@jacobs.com](mailto:gabe.ng@jacobs.com)



# Questions & Feedback?



Gabe Ng, P.E.  
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# Meander Bar

